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FATIGUE MODIFICATION OF TA15 TITANIUM ALLOY WELDMENTS BY AN ULTRASONIC IMPACT TREATMENT

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ABSTRACT

The welded components of TA15 titanium alloy were ultrasonically impact treated. The fatigue lives were investigated under the same test conditions. The fatigue strength was determined by stair-step method and the residual stresses were analyzed by an X-ray diffraction stress tester. The results show that the fatigue properties of TA15 titanium alloy welded components are sensitive to the surface treatment and ultrasonic impacting can prolong the fatigue lives. The effect of fatigue strength improvement mainly depends on compressive residual stresses and grain refinement.

1. INTRODUCTION

Welding is a main jointing method of different metallic components and the fatigue property is a critical issue of the application of welded components. Many surface enhancement processes such as shot peening (Ali, An, Rodopoulos, Brown, O'hara, Levers and Gardiner, 2007), laser peening (Hatamleh 2009), and water jet peening (Tönshoff, Kroos and Marzenell, 1997), were employed to increase the fatigue properties of welded components, and recently ultrasonic impacted peening has been developed and used by aircraft manufacturers (Liu, Wang, Deng, Xia, Huo, Wang and Gong, 2014). Compared with the conventional shot peening which is widely employed in industry, ultrasonic impacting uses the head of a ball to impact the critical local positions of welded components, as shown in Fig. 1. The objective of this work is to investigate the residual stress field induced by the ultrasonic impacting with the focus on its effect on the fatigue performance of welded components.

4. CONCLUSIONS

The welded components of TA15 titanium alloy were ultrasonically impact treated with the characterization of microstructure, the measurement of surface residual stress, fatigue properties and the observation of the fracture surface. The following conclusions can be drawn.

(1) Welding induces tensile residual stresses, while ultrasonic impacting can introduce compressive residual stresses in the surface layer.

(2) An ultrasonic impact treatment increases the fatigue life with an enhancement factor of 1.73 under 500MPa.

(3) An ultrasonic impact treatment increases the fatigue strength from 321MPa to 361MPa by 12.4%.

(4) Fatigue cracks initiate at the surfaces for the welded specimens, while for ultrasonic impact treated samples, most of the cracks initiate at the defects beneath the surface.

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